

Green Age Buildings – The New Challenges for Commissioning

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Synopsis

This paper provides a précis of the issues facing building services commissioning in Australia and the current shortcomings. It looks at the drivers and trends in the industry that are demanding change to commissioning practices including the requirement for more sustainable buildings and building practices, the demand for higher quality building services and better indoor environments, and the uptake of new technologies and the integration of active and passive building systems

Out of these the paper identifies the commissioning related challenges that face the industry in the areas of the specification of commissioning requirements and designer involvement in commissioning, technical and management skill shortages, Industry knowledge gaps, technology application, new building delivery methods and management, assuring energy and environmental targets are realised, and commissioning management and knowledge capture and management.

The paper offers a series of recommendations or “calls for action” for change to meet these challenges.

INTRODUCTION

The need to develop a better approach to building services commissioning currently has a high level of prominence. Whilst this may be largely because the expectations of many new “green age” high performance buildings are struggling within the traditional building delivery process there are additional drivers that are also demanding better outcomes from new buildings. Commissioning already faces considerable challenges within what has become the normal building delivery paradigm driven by cost and time and not to any large extent by performance outcomes or in many instances quality.

What are the drivers for change, what are the issues that the industry faces in meeting these challenges and what is a way forward?

DRIVERS FOR CHANGE

“**Sustainability**” is the current catch cry and arguably the biggest issue influencing the building industry at the present time. We now have a consciousness of the effect that buildings have on the environment and the need to minimise this for the long term. There is an increasing understanding that this is about ongoing performance outcomes, particularly with respect to energy and water consumption, and that these are effectively set by commissioning. As an outworking of this consciousness we have seen the development of energy and environmental building rating systems such as the Australian Building Greenhouse Rating System (ABGRS) and the Green Building Council of Australia “Green Star” suite of environmental rating tools. Whilst the ABGRS has no direct impact on commissioning the Green Star rating tool has very specific requirements in this area.

The Green Star Office Design Rating System offers a credit for, “where it is demonstrated that comprehensive pre commissioning, commissioning and quality monitoring are contractually required to be performed by the appropriate contractors and trades on site (in accordance with ASHRAE Guideline 1, CIBSE Commissioning Codes)”

“An additional credit is awarded where the credit above is achieved and the design team and contractor are required to transfer information and documentation to the building owner/ manager”

A further credit is available, “where it is demonstrated that a commitment is made to a firm 12 month commissioning building tuning period after handover. This requires minimum quarterly reviews and a final recommissioning after 12 months of operation.”

Another credit is awarded, “where it can be demonstrated that an independent commissioning agent has been appointed to provide commissioning advice to the client and the design team and to monitor and verify the commissioning of HVAC and building control systems.”

Comprehensive evidence is required for audit by an independent assessor in order to achieve these credits and the role of the Independent Commissioning Agent is a powerful agent of change.

Quality is making a comeback to building services after a substantial downgrading during the late 1980’s and 90’s. There is now a very significant concentration of building ownership in the hands of institutional type investors with a long term focus on the performance of the asset. This is translating to a new appreciation of life cycle issues and an improved understanding of the correlation between well performing building services and tenant satisfaction and retention. This is particularly true with air conditioning and the developing empirical connection between the quality of the indoor air environment and occupant health and productivity.

The broader market is being influenced with higher expectations for installed services and much higher expectations for their performance over time. Again it is becoming recognised that this relates strongly back to the commissioning of the building and its systems.

Technology plays a central role in our quest for better performing buildings and building services. Building services systems have become very sophisticated and are increasingly integrated and increasingly interdependent. This has made the design process and the installation more complicated and has very significantly increased the complexity of the challenge that faces building services commissioner's in delivering the performance promised by the systems design and the technology itself.

These drivers are challenging the design and construction process to deliver a much improved product. A close integration of the design, construction and commissioning process is required to delivering a high performance, operationally energy efficient and environmentally conscious building. To produce the required outcomes significant changes are required to the way we go about commissioning within the building delivery process.

CURRENT ISSUES

Unfortunately the commissioning process on many commercial construction projects is dysfunctional. In many ways the design and building services delivery process today is much less integrated than it was ten to fifteen years ago. There are a range of factors that have contributed to the current situation. These include:

Reduced design input from the system designers in the construction and commissioning stages on many projects. In the last 10 to 15 years, air conditioning designers in response to shrinking fees and changes in project delivery methods have in general focused more on producing documents for pricing and tender. Designers have moved away from the detailed specification of the commissioning requirements for their designs and reduced their involvement in the physical checking of the installation or its commissioning. This results in few and or unclear commissioning objectives, inadequate acceptance criteria and can lead to no more than functional testing, and the transference to the building owner and operator of only perfunctory commissioning data and generic operating and maintenance manuals. Responsibility for commissioning and system outcomes and for setting out detailed maintenance and operational requirements has fallen increasingly to the installers. Often this results in systems commissioned to a standard method rather than one that is most appropriate to the particular design, this becomes much more important with complex designs and sophisticated integrated systems where the best commissioning approach is not readily apparent. Whilst it should be noted that the extent to which this has happened appears to vary around Australia this trend must necessarily be reversed if energy efficient designs are to be correctly installed and commissioned for the desired outcome.

The general trend towards a **construction management style of building delivery** with a focus on construction outcomes rather than the design outcomes or life cycle outcomes has seen the responsibility for the management and coordination of systems commissioning fall to the trades sub contractors. As a result many builders and constructors have limited corporate understanding of the commissioning process and this is reflected in their systems and the skills of their project managers who are used to leaving the commissioning details to the "subbies". When confronted with a Green Star project or a complex project requiring a comprehensive commissioning management approach the traditional building delivery process struggles both in terms of management process and management skills.

Whilst there may be an adequate inclusion for commissioning at the start of a project this is often treated as a time contingency and eaten away by delays during construction. As a consequence commissioning is often **carried out under considerable pressure in a limited period of time at the end of the job** and with hand-over deadlines and delay penalties threatened by contractual masters with little understanding of the issues. As a consequence from a total project perspective systems commissioning is seen as a necessary evil, is typically poorly programmed and planned across trades and relies heavily upon informal sub contractor cooperation.

The sophistication and complexity of building systems technology and the consequent move towards **increasing specialisation and isolation of installation trades** is combining to produce non integrated systems and technology applications that do not fully deliver the promised benefits. The commissioning skills, and general knowledge and understanding of commissioning requirements that used to be an integral part of many trades are being substantially diluted as the

installation becomes increasingly sub tasked. There are also issues associated with competencies and accreditation.

An area of particular concern in this respect given the central role that building automation now plays in the performance of building systems, is the controls industry. The advent of Direct Digital Control systems has seen an increasing focus in the building controls industry on information technology and software and a general reduction of skills with respect to mechanical systems. There was a time when a controls specialist could be counted on to have a detailed understanding of the mechanical systems and plant to be controlled. More and more building controls technicians have only a rudimentary understanding of the devices they control and see them simply as inputs and outputs to the software algorithm. The focus is on the software and IT and not the building services outcome. Additionally there is little back training, as people leave the industry they are replaced with those trained in only the latest software.

In general it is the mechanical installer that has retained commissioning skills and often by default ends up with the responsibility, actual and tacit, for the coordination of commissioning across trades to achieve an integrated outcome. We have also seen the advent of the specialist commissioning sub contractor, usually from a mechanical background to fill this role.

Commissioning is typically ***seen as a set up process, not as part of an iterative tuning process.*** It is focused on getting the systems to work and is treated as effectively the last stage in the project before handover. It's done with the ambient climatic conditions at the time and it's done with the building unoccupied. To properly commission and tune building systems for performance outcomes the commissioning period must be extended into the defects liability or warranty period, and beyond. The warranty period should become a period of tuning and checking to ensure that the systems are performing at their optimum efficiency during all climatic variations for the occupied building.

A WAY FORWARD

In a product life cycle sense in Australia we are still at an early stage in developing our abilities to create low environmental impact buildings and buildings designed from a life cycle ownership perspective. There are very few green buildings that have gone through the complete process of design and construction to a design rating, and then successfully performed in operation and achieved an operational rating. As an industry we are yet to identify many of the key issues that affect the successful transition from green design idea to operationally green building.

The need for change is apparent however needs to be more widely recognised. There are areas where all participants in the building delivery process can act to improve.

Builders and Developers

The traditional building delivery process must be enhanced to incorporate a comprehensive commissioning planning and management approach. Builders and developers who aspire to delivering high performance buildings including Green Star rated facilities need to take responsibility for the commissioning process, develop "end to end" commissioning management procedures, and acquire the skills and resources necessary to manage and assure the delivery of the required performance outcomes. There is a skill gap in this area and it needs to be filled.

Both the CIBSE Commissioning Management Code M: 2003 and the ASHRAE Guideline 0 – 2005 provide very good if different blueprints that can be applied for developing procedures, and management infrastructure including commissioning planning and programming systems, Commissioning Management Plans and Inspection Test Plans.

Designers and Specifiers

The designer has a pivotal role in the successful commissioning of high performance building services and as such should take responsibility in providing direction and guidance to those charged with carrying out the work. Firstly by adequately conveying to the installation and commissioning contractors an appropriate understanding of what the systems are to do and secondly how they are to be commissioned to ensure that they operate as envisaged. Unless directed differently contractors will install and commission systems to ensure it works but not ensure works efficiently.

To commission and set up a system or combination of systems to not only provide reasonable internal conditions but also do this in the most efficient way possible over all the seasons requires an addition to the traditional set of commissioning information and guidelines, and also in some instances, a different commissioning approach. It requires the designer to have a good

understanding of how the systems will work and consume resources and how these systems should be tuned in the initial commissioning phase and then require tuning over the ensuing period as the building is occupied and the seasons go through their annual cycle.

Energy efficiency indicators for application at commissioning need to be derived from the design and energy model by the designer. These should answer the question, “how can we test my built design to ensure it is performing as intended, is energy efficient etc.”. This should run to a series of empirical tests / indicators for the building systems that will be enhancements to the standard tests, flows, temperatures etc. It should run to much broader “system” assessments of water and air flows and temperatures and extend into the detail of measuring energy usage / load profiles on installed plant. BAS /DDC systems have a considerable as yet unfulfilled role to play in energy efficient commissioning.

There is much work to be done in this area; there are considerable knowledge and skill gaps as the design process has in many cases become “open loop” with little or no feedback from the systems installers, commissioners and operators to the designers. Designers should seek input from installers and commissioners on “build-ability” and “commission-ability” issues.

Designers should consider specifying commissioning guidelines and standards such as those published by the National Environmental Balancing Bureau (NEBB) or CIBSE to assure commissioning standards on their projects. The NEBB Building Systems Commissioning approach deals with the commissioning of integrated systems. The competencies and qualifications required for those carrying out the commissioning should be specified. It is essential that the requirements for commissioning are detailed and effectively communicated to installers and commissioners and that they are able to make adequate cost and resource provisions for these requirements in their pricing.

Where they have influence over the building delivery process and the building is not to be Green Star rated designers and specifiers should consider the application of an integrated commissioning management process either based on the Green Star commissioning requirements or the process set out in CIBSE Commissioning Guide M or ASHRAE Guideline 0 – 2005

Contractors and Commissioners

The future will pose challenges and significant opportunities for those responsible for carrying out building commissioning. Energy and environmental building rating systems in particular will drive change in the industry because commissioning skills and knowledge will be drawn into play by these rating systems at every stage of the building’s life cycle. Designing to meet energy consumption targets, installation of increasingly integrated and complex systems, introduction of new technology and concepts, commissioning to achieve energy and water usage commitments and other performance parameters, commissioning integrated multi services systems, and structured systems tuning to achieve and maintain star ratings, all will challenge building commissioning specialists to build new skills and apply existing skills in new ways.

The demand for commissioning to grow and develop can be expressed in three dimensions:

Time and Duration of Involvement: The requirement to design and demonstrably deliver a measured performance outcome (e.g. energy and or environmental rating) will require commissioning skills and services to be involved much earlier than they now typically now are, and cause them to stay involved over the life of the building in some shape or form to help keep the building tuned to ensure it keeps its (annually audited) Star Rating. Systems ideally should be regularly tested and tuned to optimise time schedules to best match occupant needs and system performance, and to align the systems operation to the attributes of the built space it serves. As the energy consuming systems and the building are an inter-linked physical system things like warm up times, cool down times, night purge conditions, chiller scheduling, base lighting levels and the like will reflect the physical interaction between the services and the building and this will vary during the year. Commissioning records should be used to track various indicators and as such there is considerable opportunity for building automation systems to produce controls “silhouettes” describing acceptable parameters for air flow and temperature distribution throughout a building allowing tracking over time and reporting by exception.

Technical Skills and Knowledge: Increasing integration of the physics of the building and occupant behaviour with the energy consuming building services, and the increasing integration of these systems themselves will require developments in commissioning sophistication. A more holistic commissioning approach will be required to ensure the achievement of the promised performance levels for the building as a whole. Already environmental rating requirements are causing the relatively well developed commissioning skills and approaches developed for mechanical systems

to be applied to other systems that traditionally haven't been commissioned as thoroughly e.g. lighting, hydraulics (water supply and waste management) and active building systems like operable facades, other natural ventilation systems and active / passive thermal storage systems.

Reporting and Management Skills and Attitudes: The ability of building commissioners to work at different levels and in different ways in projects to what has become the norm needs to be developed. Whether this is at design stage providing input not just on "build-ability" issues but also "commission-ability" and energy consumption realities, or as part of the installation team that has a responsibility to meet energy targets, or as part of an operation and maintenance service provider team that is required to maintain or better a level of energy and water usage to keep or improve a building star rating.

Industry

Some of these suggested developments will come to pass as an evolution of current practices and competitive market forces and industry members will grow and better themselves accordingly. Other developments may require the industry to take the initiative to facilitate and drive change.

Training and Accreditation: A number of skill gaps exist in both the management and coordination of commissioning and in the technical aspects of commissioning. These gaps need to be addressed by training, preferably industry based. There is also the need to further develop and promote the requirement for accreditation of commissioning technicians and organisations. A single industry accepted system should be the aim and the NEBB system should be considered as a basis for this.

Knowledge and Information: As an industry we are beginning to understand the challenges involved in delivering high performing buildings. There is a need to share what is being learnt from leading edge projects and practitioners and opportunities should be created to provide forums for discussion and knowledge sharing. There are also emerging a range of knowledge and information gaps. Whilst the Green Star rating system specifies a frame work for commissioning and the CIBSE Commissioning Guide M and the ASHRAE Guideline 0 – 2005 both provide guidelines for the integration of commissioning into the building delivery process it is also worth noting that both the CIBSE and ASHRAE guides are published overseas and not entirely applicable to the Australian industry. There may be value in developing complimentary guidelines or standard documents for commissioning management in the Australian context.

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Bryon Price is a Mechanical Engineer with notable experience in energy efficient buildings. He is Business Development Director for the A.G.Coombs Group of companies. Prior to joining A.G.Coombs Bryon was responsible for a range of energy and environmental projects. These included long term energy management roles with a number of major financial, commercial and retail organisations, and various Commonwealth and State Government Departments, and the preparation and management of a number of innovative energy and environmental performance briefs for major building developments. Out of this experience his particular area of knowledge and interest is "whole of life" energy and environmental management in buildings.

References:

1. ASHRAE: Guideline 0-2005 - The Commissioning Process, American Society of Heating, Refrigerating and Air Conditioning Engineers Inc.
2. ASHRAE: Guideline 1 – 1996 - The HVAC Commissioning Process, American Society of Heating, Refrigerating and Air Conditioning Engineers Inc.
3. Australian Building Greenhouse Rating Scheme: www.abgr.com.au
4. CIBSIE: Commissioning Code M: 2003, Chartered Institution of Building Services Engineers
5. CIBSIE: Guideline F- Energy Efficiency in Buildings, pp 216 – 220, Chartered Institution of Building Services Engineers
6. Green Building Council of Australia: Green Star Office Design V2 Technical Manual,
7. Hebert, J.: "Managing Commissioning", AIRAH Journal, Volume 55, Number 7 July 2001
8. Hopkins, I.: "The Importance of Engineering Services Commissioning", Climate Control News, Volume 2, Number 11 November 2003
9. NEBB: Procedural Standards for Buildings Systems Commissioning, National Environmental Balancing Bureau
10. Price, B.J.: "Designing for Energy Efficient Operation", EcoLibrium – The Official Journal of the Australian Institute of Refrigeration, Air-Conditioning and Heating, Volume 2, No. 2 March 2003
11. Stannus, W.B., Price, B.J.: "Integrated Systems Commissioning", Systems Design Approach for Air Conditioning Conference, The Australian Institute of Refrigeration, Air Conditioning and Heating, Sydney, March 2005
12. Stannus, W.B., Price, B.J.: "The Green Age Building: Energy and Environmental Building Rating, What it means for Commissioning", National Environmental Balancing Bureau 2004 Annual Dinner, Melbourne, December 2004
13. Wright, C.V.M.: "The Responsibility of the Mechanical Contractor", Seminar on Commissioning Air Conditioning Systems, The Australian Institute of Refrigeration, Air Conditioning and Heating Melbourne, 10 November 1971
14. Young, P.C.: "The Role and Responsibilities of the Consulting Engineer", Seminar on Commissioning Air Conditioning Systems, The Australian Institute of Refrigeration, Air Conditioning and Heating Melbourne, 10 November 1971